Total Pages—6

B.Tech-2
Phy

Set-3

PHYSICS

Full Marks : 70

Time : 3 hours

Answer **six** questions including **Q. No. 1**

The figures in the right-hand margin indicate marks

All parts of this question must be answered at one place

Mass of electron = $9{\cdot}11 \times 10^{-31}$ kg, Mass of proton = $1{\cdot}67 \times 10^{-27}$ kg, Plank's constant = $6{\cdot}62 \times 10^{-34}$ Js, Boltzmann constant = $1{\cdot}38 \times 10^{-23}$ J/K

1. Answer *all* the following questions : 2 × 10

(*a*) Write down two equations which indicates that unit of damping coefficient is same as that of frequency.

(*b*) Define wave as periodic variation of physical quantity in space and time.

(*Turn Over*)

(*c*) What will happen if a plane mirror is placed instead of glass plate in Newton's ring experiment ?

(*d*) How many lines per centimeter does a grating have if the third-order occurs at an 18·0 degree angle for 630 nm light ?

(*e*) Write down the formula for $\overline{\nabla \times \nabla \varphi}$ and $\nabla \cdot \nabla \times \bar{F}$. Symbols have their usual meanings.

(*f*) Evaluate $\nabla \cdot \vec{r}$ where $\vec{r}$ is the position vector.

(*g*) Explain how the construction of zone plates and Newton's rings are interrelated with each other.

(*h*) An electron is confined within a spherical region of radius 8 Fermi. Use the uncertainty principle to estimate the relativistic kinetic energy for the electron localized inside the spherical region.

(*i*) Write down few laws of photoelectric effects.

(*j*) Show that the speed of the particle in one dimensional potential well of infinity height is quantized in contradiction to classical physics.

2. (*a*) Show that the phase difference between forced oscillation and applied force depends upon the frequency of the applied force and damping coefficient of the medium. 5

(*b*) Explain the phenomenon of reflection of longitudinal waves at the boundary of rarer medium and denser medium. 5

3. (*a*) Why do the fringes get closer and finer as we move away from the centre in case of Newton's rings ? How can you obtain central bright fringe ? 5

(*b*) Diffraction phenomenon can be exploited technologically to measure the diameter of small suspended particles. Explain it. Does it depend on wavelength ? 5

4. (*a*) Explain the phenomenon of polarization of light by reflection. 5

(b) A Nicol prism is placed in the way of partially polarized beam of light. When the prism is turned from the position of maximum transmission through an angle $\theta = 60^\circ$, the intensity of transmitted light decreased by a factor of 3·0. Find the degree of polarization of incident light. 5

5. (a) Give a comparative account between zone plate and convex lens. 5

(b) The sodium vapor light has two closely spaced wavelengths 5890 Å and 5896 Å. This light is incident on a grating with 12000 lines/inch. Find the angles of diffraction for the principal maxima of the two wavelengths in the first order spectrum. Can this grating resolve sodium vapor light? 5

6. (a) For a dielectric medium $\sigma = 0$, $\mu_r = 5{\cdot}0$ and $\varepsilon_r = 2{\cdot}5$. Examine whether the pair of fields $E = 6z\hat{z}$ and $H = 7y\hat{y}$ satisfy Maxwell's equation. 5

(b) A plane wave is polarized with its electric vector along z-axis. The wave ($\lambda = 0{\cdot}10$ m) propagates in vacuum along the y-axis. The electric field is given by $E_z(y, t) = 5e^{(ky - \omega t)}$ V/m. What is the frequency of the wave? How large is the magnetic field associated with this wave and in what direction is it oriented? 5

7. (a) What are the characteristics of wave functions of matter wave? 5

(b) Electrons with energy 10·0 eV are incident on a potential step of 8 eV high and 0·50 nm width. Calculate the reflection probability and transmission probability of the incident electron. 5

8. (a) List the conditions a wave function must satisfy in order to solve the Schrödinger equation. 5

(b) Write down the time-independent Schrödinger equation for a particle moving in one dimension (x) in a region of space where the total energy is less than the constant potential energy V. Show by substitution that the spatial wave function $\psi(x) = Ae^{\alpha x} + Be^{-\alpha x}$ where A and B are constants, is a solution of this equation and find α in terms of E and V. 5
